REMARKS

Pending claims

Assuming entry of this amendment, claims 1-2, and 4-19 are pending, of which claims 1, 4, 15, and 19 are independent. Claim 20 was previously canceled in response to a restriction requirement.

Drawings

Referring to term "duty cycle" in claim 18, the Examiner required a drawing that shows this feature. The applicant has resolved this issue in a different manner, namely, simply by deleting the phrase in claim 18 that included "duty cycle." As the IEEE Standard Dictionary of Electrical and Electronic Terms, 3rd Edition, 1984 explains, the general definition of "duty cycle" is "the time interval occupied by a device on intermittent duty in starting, running, stopping, and idling."

In the context of this invention, the phrase at issue in claim 18 related to how only one LED in each reversed-polarity pair will be forward biased at any given time when the power source supplies alternating current (ac). This is explained in, among others, paragraphs [0037] and [0047] of the specification. Claim 14 (which originally stated that the supplied power is unregulated ac) has now been amended to state that only one of the LEDs in each LED pair will be forward biased at any given moment. There is therefore now no need to recite "duty cycle" explicitly in claim 18 (which has been made dependent on claim 14), since the concept of a partial duty cycle is inherent in the circuit description found in claim 1, and the known properties of diodes and alternating current.

Claim Rejections

Rejections Under 35 U.S.C. 112

The Examiner rejected claim 1 because of vagueness of the term "the other." Claim 1 has been amended to recite that each pair of LEDs includes a first LED and a second LED; the various anode-cathode connections are referenced to "first" and "second," so that "the other" is no longer used.

The Examiner also rejected claim 1 for lack of antecedent basis of "the anode." First, the applicant notes that it is well known in electrical engineering that every diode has an anode and a cathode. Second, although the Examiner did not do so, the applicant assumes that the objection to "*the* anode" would also apply to "*the* cathode." Claim 1 has been amended to recite that "***an*** anode of the first LED in each pair is electrically connected to ***a*** cathode of the second LED in the pair, and ***an*** anode of the second LED in each pair is electrically connected to ***a*** cathode of the first LED in the pair." This formulation makes the connections unambiguous and provides antecedent basis for all terms.

Also, although the Examiner allowed claim 19, it also included the phrases "the other" and "the anode." Claim 19 has accordingly been amended as claim 1 so as to remove all potential issues concerning these terms.

The Examiner rejected claim 3 because the "n" in "n parallel paths" was not defined. The limitations of claim 3 have been incorporated into claim1, and n is now defined as a predetermined positive integer greater than one. Although the Examiner did not raise the issue, the parameter "m" (the number of series-connected reverse-polarity LED pairs in each parallel path) has also been defined as a predetermined positive integer.

The Examiner required clarification of "after-market fitting" in claim 10. The applicant respectfully submits that the term "after-market" (sometimes written "aftermarket") is well established for products in almost every area of commerce. Nonetheless, claim 10 has been amended to replace and thereby clarify the text defining the intended feature.

Rejections Under 35 U.S.C. §102

The Examiner rejected claims 1-3, 14 and 17 as being anticipated by U.S. Patent No. 6,069,452 (*Rossner*). Although *Rossner* does show a matrix of LEDs with some having reverse polarity relative to others, there are several differences between *Rossner's* arrangement and the applicant's invention as now claimed. These differences all stem from one essential difference, however: *Rossner*, by explicit design, ***cross-connects*** his "columns" of LEDs; in the embodiment of *Rossner* illustrated in his Figure 1, the cross connections are labeled 16 and 17.

Thus (emphasis added):

Col. 2, lines 19-21 and 39-41:

... there is provided, in accordance with the invention, a circuit configuration, comprising ... **cross-connections** interconnecting the electrical sections ***at all junction nodes*** between the LEDs, defining a multiply redundant matrix of LEDs.

Col. 2, lines 42-48:

In other words, in each case one LED of the first group is combined with an LED of the second group, the latter LED being operated antiparallel with the former LED, in a housing. Further, at least one junction point between two LEDs of the first group is connected to at least one junction point between two LEDs of the second group by **a cross-connection line.**

Col. 3, lines 9-13

Each of the two groups of LEDs comprises a plurality of electrical sections which are connected in parallel and each have a plurality of series-connected LEDs. These electrical sections are **interconnected *at all the junction points*** of the individual LEDs.

Col. 3, lines 55-59

... each junction node formed between two LEDs of one section is in each case connected to exactly one junction node between two LEDs ***of every other section*** by means of a respective **cross connection.**

Consider the LEDs to be in columns and rows. One consequence of the cross-connections is that *Rossner's* LEDs are not paired: In *Rossner*, all the same-polarity LEDs are in the same "group" (col. 4, lines 32-33: "... six LEDs 4 to 9 and six LEDs 10 to 15 respectively form a first and a second group of LEDs"); and all the LEDs in the same column of the matrix form a "section" 18-21 (see col. 4, lines 37-39). There is never any association of a single forward-biased LED with a single, relatively reverse-biased LED.

In contrast, claim 1 has been amended to make clear that the n parallel paths of m series-connected anti-parallel LED pairs "share common power connections but are ***otherwise electrically separated from each other*** such that electrical current entering each parallel path passes through the m series-connected LED pairs of only that parallel path" (emphasis added). In other words, in the applicant's invention as now claimed, no LED-to-LED junction in any column (parallel path) is ever cross-connected with any such junction in a different parallel path. In short, the applicant's electrical paths are truly parallel.

The applicant's arrangement is much more robust than *Rossner's*, as can be seen from both electrical and fabrication-related considerations. As in any diode matrix, the supplied current is shared by the various devices. In order to optimize the energy transfer from a given energy source to each individual device without requiring complicated and expensive controlling circuitry, the current through the LEDs should be shared as evenly as possible; substantially even sharing also prevents one set of LEDs from being consistently loaded more heavily than others, thereby shortening their life expectancies. Although LEDs appear identical to each other in a circuit diagram, in practice most display variations in electrical and thermal properties. For example, commonly available white LEDs typically have a forward voltage that can vary between 3.0V to 3.6V at 25mA and 25 degrees Celsius. Even LEDs fabricated from the same wafer can display a forward voltage variation of up to a few volts.

One practical advantage of having the n parallel LED branches be truly parallel (not electrically connected other than at the power supply junctions) is that the LEDs in each branch can be presorted to within a desired voltage range, keeping in mind the

expected operating conditions such as variations of the voltage source, variations of LEDs characteristics, and the environment that the LEDs operate in. If, as in *Rossner*, the "parallel" paths are in fact interconnected, it is difficult or impossible to select which LEDs to use, since all of the LEDs in effect influence all others; for example, the temperature is usually not the same for different LEDs in the matrix as they are located physically apart from each other.

The robustness of separate, that is, non-interconnected parallel paths is ruined if the paths of different branches are crossed. In arrangements such as *Rossner's*, the LED with the lowest forward voltage in any given crossed path will take the most current, which causes even further lower forward voltage. This instability then leads to a classic thermal runaway case. In short, *Rossner's* inherently uneven sharing of current is exactly what designers want to avoid.

Of course, *Rossner's* interconnection is not chosen as a random feature, but is intended to meet his goal of creating an LED matrix that is "multiply redundant." One stated purpose of this multiple redundancy is to overcome the previous problem in traffic lights:

> Col. 1, lines 51-62:
> … that the components used in ballasts … do not comprise fault exclusions. Therefore, the ballasts cannot be regarded as an intrinsically safe assembly. For this reason, and because the ballasts are so complex in their entirety that internal monitoring can no longer be carried out reliably, it is necessary to use sensors to measure or meter an inhibit or stop signal, in particular. … Complex ballasts of this type, which additionally require a failure recognition configuration, can only be produced with high costs.

The applicant's invention as defined in claim 1 therefore now clearly recites a key feature (n truly parallel paths, each comprising m series-connected ***pairs*** of anti-parallel LEDs) that is wholly lacking in *Rossner* – in fact, that *Rossner* specifically teaches away from – and that provides the advantage of

greater circuit robustness and reliability. Claim 1 should therefore be allowable, along with the claims that depend from and thus further limit claim 1.

Non-obviousness

The Examiner did not reject any claims under 35 U.S.C. §103 as being obvious in view of any combination of references or "Official notice." Over the past couple years, however, the applicant's attorney has noticed an increasing tendency for the Office to issue a second action rejecting, for the first time, claims under 35 U.S.C. §103, using a combination of references that could have been hypothesized in the first Office action, but then making the second action final. This then forces an applicant to file a Request for Continued Examination and pay an additional filing fee to respond to the new rejection, even though the §103 rejection could have been made earlier.

In hope of avoiding such a situation, and of furthering the successful prosecution of this application, the applicant therefore wishes to note that *Rossner* teaches that the interconnections are a key element of accomplishing his goal of defining a "multiply redundant matrix" of LEDs (see the several citations above). As such, *Rossner* specifically teaches away from any circuit arrangement such as the applicant's in which LED-LED junction interconnections are lacking.

Allowable subject matter

The Examiner stated that claims 4-13, 15, 16, and 18 would be allowable if rewritten to overcome the §112 rejections and to include all the limitations of the base claim (claim 1) and any intervening claims.

Claim 4 has been amended to be an independent claim that now includes the limitations of claim 1, including the amendments to claim 1 discussed above. Claim 4 and its dependent claims 5-13 should therefore now be allowable.

Claim 15 has likewise been amended into independent form to include the limitations of claim 1, including the amendments to claim 1 discussed above. Claim 15 and its dependent claim 16 should therefore now be allowable.

The dependency of claim 18 has been changed (see also discussion of the "duty cycle" rejection above) to claim 14, but its base claim is still claim 1. The applicant respectfully submits that claim 18 should be allowable along with claim 1, but has declined to turn claim 18 into a separate independent claim at this time.

The Examiner has allowed claim 19. Note that this claim has nonetheless been amended, as discussed above.

Conclusion

All of the claims have now either been allowed outright, have been converted into a form that the Examiner has said would make them allowable, or have (in their own right or through their base claim 1) been amended to recite advantageous features not found in the prior art. Consequently, the applicant respectfully requests that all of the claims be allowed.

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